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UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
(San José Division)

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| CALVARY CHAPEL SAN JOSE, a California Non-Profit Corporation; PASTOR MIKE MCCLURE, an individual; SOUTHRIDGE BAPTIST CHURCH OF SAN JOSE CALIFORNIA dba SOUTHRIDGE CHURCH, a California Non-Profit Corporation; PASTOR MICAIAH IRMLER, an individual,<br><br>Plaintiffs,<br><br>v.<br><br>GAVIN NEWSOM, in his official capacity as the Governor of California, ERICA PAN, M.D., in her official capacity as the Acting California Public Health Officer; SANTA CLARA COUNTY, SARA H. CODY, M.D., in her official capacity as Santa Clara County Public Health Officer; MIKE WASSERMAN, in his official capacity as a Santa Clara County Supervisor; CINDY CHAVEZ, in her official capacity as a Santa Clara County Supervisor; DAVE CORTESE, in his official capacity as a Santa Clara County Supervisor; SUSAN ELLENBERG, in her official capacity as a Santa Clara County Supervisor; and JOE SIMITIAN, in his official capacity as a Santa Clara County Supervisor,<br><br>Defendants. | No. 20-CV-03794 BLF<br><br>**DECLARATION OF DR. MARC LIPSITCH IN SUPPORT OF DEFENDANTS' OPPOSITION TO EX PARTE APPLICATION FOR TEMPORARY RESTRAINING ORDER AND ORDER TO SHOW CAUSE**<br><br>Date: December 17, 2020<br>Time: 2:30 p.m.<br>Crtrm: 3<br>Judge: Beth Labson Freeman |

I, DR. MARC LIPSITCH, declare as follows:

1. I am a resident of Jamaica Plain, Massachusetts. I have personal knowledge of the matters set forth below and could testify competently to them if called to do so.

**Professional Background**

2. I am the founding Director of the Center for Communicable Disease Dynamics (CCDD) at the Harvard School of Public Health, where I am also a Professor in the Department of Epidemiology and the Department of Immunology and Infectious Diseases. I have a B.A. in Philosophy from Yale University and a DPhil (the Oxford equivalent of a PhD) in Zoology from the University of Oxford, which I attended as a Rhodes Scholar. After receiving my DPhil, I completed a postdoctoral research fellowship in Biology at Emory University working on the population biology of infectious diseases. A copy of my C.V. is attached to this declaration as Exhibit A. I have been elected as a Fellow of the American Academy of Microbiology and a member of the National Institute of Medicine for the United States.

3. CCDD is a research center committed to advancing our understanding of infectious disease and training the next generation of scientists. It was founded as a Center of Excellence in the Models of Infectious Disease Agent Study funded by the National Institute of General Medical Sciences of the U.S. National Institutes of Health (NIH). CCDD has been at the leading edge of epidemiology, pioneering new approaches and methodologies for investigating both recurring and emerging problems. The goal of our work at CCDD is to understand why and how infectious disease persists and changes and use that knowledge to lessen its burden on people.

4. CCDD is closely monitoring the progress of COVID-19. CCDD faculty—including me—are conducting research on the novel coronavirus SARS-CoV-2 and COVID-19, the disease it causes. CCDD faculty have published over 50 peer-reviewed articles about SARS-CoV-2 and COVID-19. I am the lead or a contributing author on more than 20 of those articles. CCDD faculty regularly host and contribute to online events about COVID-19, appear in national and international media, including print and broadcast news, and participate in scientific conferences, consortia, discussions, debates, and podcasts, as well as advising local, state, and federal officials and leaders of countries around the world.

5. My own work on COVID-19 has included epidemiology, mathematical modeling, and exploration of ethical issues related to vaccine trials and school reopenings. My research has helped identify countries with undetected cases before they were reported; modeled the effects of various social distancing and quarantine strategies; and contributed to some of the earliest estimates of case-fatality rates. My research has also addressed new methodologies on how to study immunity to COVID-19; and I am a co-lead on a large collaborative effort, led by experts at the University of Chicago and involving multiple European universities, to establish best practices for estimating the contagiousness of the virus. My work has also addressed the ethical aspects of COVID-19 vaccine trial design, including the first published proposal for human challenge studies, which received support from the World Health Organization (WHO) and the NIH, and which was implemented in the U.K.

6. I have advised the WHO, the International Monetary Fund, the Prime Minister of Israel, and senior government officials in the U.S., Canada, India, Germany, Austria, and Luxembourg on COVID-19, as well as the U.S. National Governors' Association and numerous state and local health officials. I am a member of the Massachusetts Governor's Medical Advisory Committee and the Massachusetts COVID-19 Vaccine Working Group. I am also an ad hoc expert to the COVID-19 Vaccine Working Group, which is part of the WHO Strategic Advisory Group of Experts. Health departments on several continents use software that I helped develop to update their estimates of trends in COVID-19 cases.

7. Over the course of the COVID-19 pandemic, I have been asked to provide and have provided interviews and analysis to national and international media outlets, including CNN, BBC, the *Guardian* and the *Wall Street Journal*; and I have published articles explaining aspects of the COVID-19 pandemic in national and international media outlets, including the *New York Times* and *Washington Post*. My public science communication efforts also include a Twitter account with an active following. Earlier this year, physicist Jonathan Oppenheim reported that I was the second-most-followed expert by other experts on the COVID-19 pandemic; and I was named by Forbes as one of the "most essential people on Twitter to follow during the COVID-19 outbreak."

8. More generally, my research has focused on biological and mathematical approaches

to infectious disease questions—mainly understanding how our immune systems and medical interventions such as antibiotics and vaccines exert natural selection on pathogens, and how the resulting changes in pathogen populations affect human disease. My more recent work has focused on antimicrobial resistance, epidemiological methods, mathematical modeling of infectious disease transmission, pathogen population genomics, immunoepidemiology of *Streptococcus pneumonia*, transmission-dynamic simulations, and ethical questions surrounding vaccine trials for infectious disease.

9. My work has addressed a number of issues relevant to modern pandemic responses. My research provided modern evidence of the moderate contagiousness of the 1918 "Spanish flu." During the first SARS outbreak in 2003, I led a team that provided one of the first estimates of the virus' reproduction number. During the 2009 H1N1 pandemic, my research produced the first reliable estimate of H1N1 flu severity. During the yellow fever outbreak in Angola and Democratic Republic of Congo in 2016, my modeling work helped support fractional dosing vaccination strategies, which helped extend vaccine availability in a shortage situation. I have written extensively on data-driven decision making in public health.

10. I have worked extensively with governments and intergovernmental bodies like WHO to address public health issues including pandemic response and preparedness. For example, in 2003 and 2004, I served on the Defense Science Board Task Force on the SARS Quarantine for the U.S. Department of Defense. In 2009, I was a member of the H1N1 Working Group of the U.S. President's Council of Advisors on Science and Technology; and in 2009 and 2010, I was a member of the Team B Advisory Body to the CDC on the Novel H1N1 Influenza. From 2017 through today, I have been a member of the Biological Agents Containment Working Group of the Board of Scientific Counselors to the Office of Public Health Preparedness and Response at the CDC.

11. I have also worked extensively on the design and analysis of vaccine trials during public health emergencies. In 2015, I served on a scientific advisory board for a major Ebola vaccine trial, and as I mentioned above, I am currently advising Massachusetts and WHO on COVID-19 vaccine issues.

12. I have published more than 330 peer-reviewed articles and a large number of other

publications, including book chapters, non peer-reviewed journal articles, and popular articles in the national press. I have also contributed to a number of reports, including the President's Council of Advisors on Science and Technology (PCAST) H1N1 Working Group's 2010 Report to the President on US Preparations for 2009-H1N1 Influenza; three reports from the Center for Infectious Disease Research and Policy (CIDRAP) regarding the development of a vaccine for the Ebola virus; and most recently an April 2020 CIDRAP report on COVID-19.[1] CIDRAP is based out of the University of Minnesota and is a global leader in addressing public health preparedness and emerging infectious disease response.

13. I continue to teach and mentor undergraduate and graduate students at Harvard, as well as supervising graduate work for doctoral candidates.

**Opinions Regarding Dr. Bhattacharya's Declaration**

14. The defendants in this case contacted me about responding to the opinions expressed by Dr. Jayanta Bhattacharya in his declaration submitted by the plaintiffs. I agreed to provide a declaration setting forth some of my professional opinions on the issues raised in that declaration. In reaching those opinions, I have relied on my knowledge, training, experience, and the kinds of data regularly relied on by experts in my field. I am working pro bono and not being compensated for my time.

15. I have read the declaration of Dr. Jayanta Bhattacharya submitted by the defendants in this lawsuit. My opinions regarding that declaration are based on the available science regarding the novel coronavirus SARS-CoV-2 and the disease it causes, COVID-19, as well as my training and experience in infectious disease response.

16. As Dr. Bhattacharya discusses in his declaration, he has recommended an approach to COVID-19 that is commonly referred to as "herd immunity with focused protection." This approach was laid out in the so-called "Great Barrington Declaration," a document published in October at a ceremony at a libertarian think tank by three scientists, including Dr. Bhattacharya. In this approach,

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[1] Moore, K., et al., *COVID-19: The CIDRAP Viewpoint*, April 30, 2020, available at https://www.cidrap.umn.edu/sites/default/files/public/downloads/cidrap-covid19-viewpoint-part1_0.pdf.

the virus would be allowed to spread among young, healthy people with little attempt to slow it down, while officials would try to keep older, more vulnerable Americans from contracting it. This strategy diverges sharply from the views of most infectious-disease epidemiologists and has been rejected by the National Institute of Allergy and Infectious Diseases Director Dr. Anthony Fauci,[2] WHO Director-General Tedros Adhanom Ghebreyesus,[3] and the more than 6,900 scientists, researchers, and healthcare professionals who have signed a formal response called the John Snow Memorandum.[4] Without a vaccine, this strategy also risks the deaths of a million or more Americans. With the FDA's recent approval of Pfizer's vaccine, and given the likelihood of FDA approval of additional effective vaccines, the strategy risks significant avoidable illness and death.

**COVID-19 Is Not Harmless For Younger Populations**

17. The assumption underlying the herd immunity approach—that COVID-19 is harmless to most people and risky only for defined groups—is false.

18. The impact of a pandemic on health depends not only on the infection-fatality rate, but also on other measures of severity such as the risk of hospitalization or ICU admission among those infected. Crucially, it also depends on the number of people who become infected, because a small risk of death, ICU or hospitalization multiplied by a large number of people infected can result in large numbers of deaths and high burdens on health care resources. Indeed, the extraordinarily high peak demand for intensive care in Wuhan, China[5] and in Northern Italy[6] were two of the

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[2] Mandavilli A., et al., *A Viral Theory Cited by Health Officials Draws Fire From Scientists*, New York Times, Oct. 19, 2020, available at https://www.nytimes.com/2020/10/19/health/coronavirus-great-barrington.html (accessed Nov. 16, 2020).

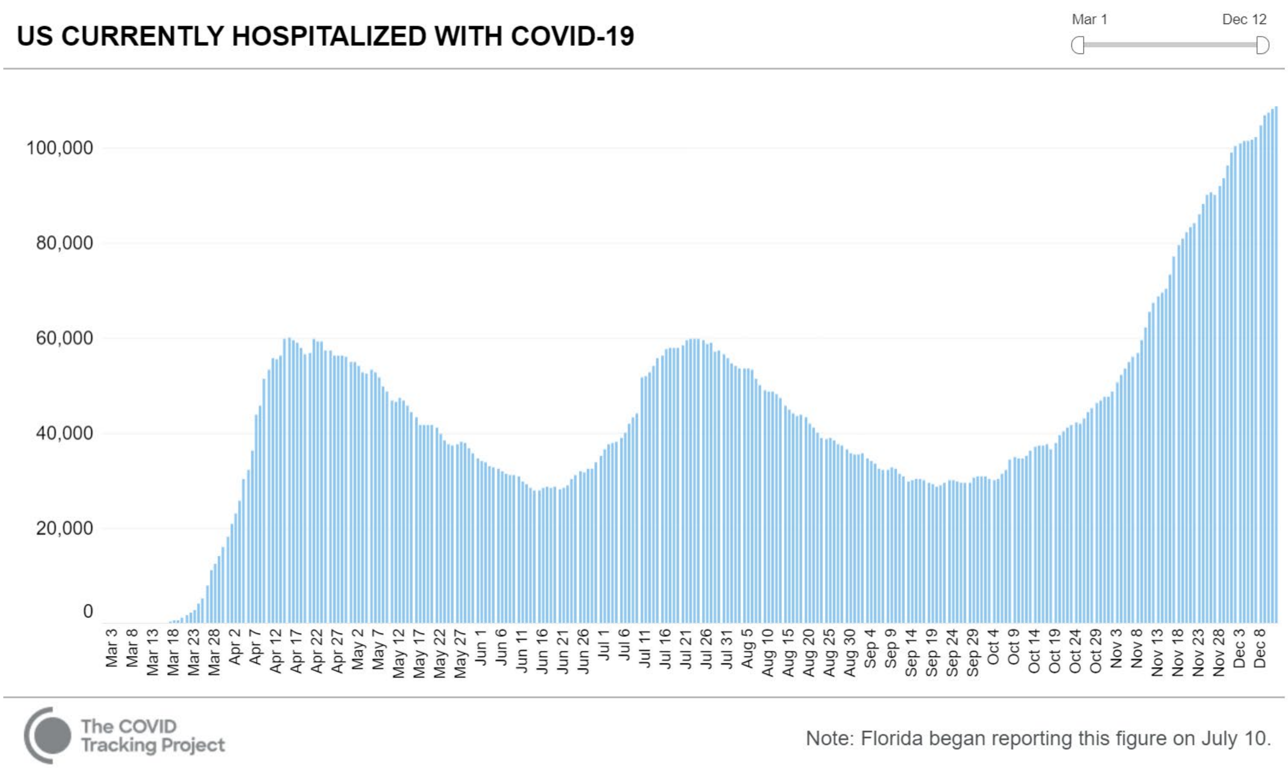
[3] *WHO chief says herd immunity approach to pandemic 'unethical'*, The Guardian, Oct. 12, 2020, available at https://www.theguardian.com/world/2020/oct/12/who-chief-says-herd-immunity-approach-to-pandemic-unethical (accessed Nov. 16, 2020).

[4] Available at https://www.johnsnowmemo.com/.

[5] Li, R., et al., *Beds for Patients With COVID-19 Based on Comparisons With Wuhan and Guangzhou, China*, May 6, 2020, JAMA Netw. Open. 2020;3(5): e208297, available at https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2765575.

[6] Grasselli, G., et al., *Critical Care Utilization for the COVID-19 Outbreak in Lombardy, Italy: Early Experience and Forecast During an Emergency Response*, March 13, 2020, JAMA. 2020;323(16):1545-1546, available at https://jamanetwork.com/journals/jama/fullarticle/2763188.

earliest warnings that uncontrolled SARS-CoV-2 spread could result in horrific burdens on the health care system. The intense stress on even very high-quality health systems is being felt across Europe and in many parts of the U.S. as of December 2020, with overloaded intensive care units in multiple locations due to COVID-19 surges. The U.S. has hit its highest number to date of hospitalizations, with more than 108,000 COVID-19 patients in hospital as of December 12, 2020:[7]




19. In this context, academic debates about the risk of severe outcomes per individual, while relevant, are better understood in the context of the total burden created: individual risk times number of individuals infected.

20. COVID-19 is unquestionably worse for someone who is male, older, sicker, or lacks access to health care. Younger, healthier demographics do better than older demographics.[8] These facts do not mean, however, that COVID-19 is harmless for younger cohorts. To date, more than

[7] The COVID Tracking Project, The Atlantic, available at https://covidtracking.com/data/charts/us-currently-hospitalized (accessed Nov. 23, 2020).

[8] CDC, *COVID-19 Hospitalization and Death by Age*, https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html (accessed Dec. 12, 2020).

52,000 Americans under 65 have died from the disease[9]—more than four times as many as typically die in that age group from seasonal flu in an entire year[10]—and we have only had about eleven months of intense COVID-19 activity, so that number will continue to grow.

21. Dr. Bhattacharya's declaration, by focusing only on those at lowest risk, significantly underestimates the SARS-CoV-2 infection-fatality rate. The best estimate to date of the overall infection-fatality rate for SARS-CoV-2 infection is by Dr. Gideon Meyerowitz-Katz and colleagues, and is approximately 0.7%.[11] Importantly, while the risk is age specific, and the infection-fatality rate increases sharply with age, there is no cutoff at age 70; rather, the risk of dying if infected with this virus "increases progressively to 0.4% at age 55, 1.4% at age 65, 4.6% at age 75, and 15% at age 85."[12] It is misleading to call the infection-fatality rate below age 70 "vanishingly small" given these risk estimates and given that over 83% of the U.S. population or nearly 274 million people are under 65 (2019 census estimate). Dr. Bhattacharya relies on a meta-analysis by Dr. John P.A. Ioannidis that estimates a lower infection-fatality rate (Para. 36), but Dr. Meyerowitz-Katz's meta-analysis is distinguished by more rigorous criteria for including studies than that by Dr. Ioannidis. While the former excludes studies expected to be heavily biased by a nonrepresentative sample, the latter does no such quality checks. On this basis, I judge the conclusions of Dr. Meyerowitz-Katz's meta-analysis more reliable.

22. If COVID-19 were judged on the criteria established for evaluating the severity of an

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[9] CDC, *Weekly Updates by Select Demographic and Geographic Characteristics*, available at https://www.cdc.gov/nchs/nvss/vsrr/covid_weekly/index.htm (accessed Dec. 12, 2020)

[10] Quandelacy, T., et al., *Age- and Sex-related Risk Factors for Influenza-associated Mortality in the United States Between 1997–2007*, Am. J. Epidemiol. 2014 Jan. 15; 179(2): 156–167, doi: 10.1093/aje/kwt235, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3873104/.

[11] Meyerowitz-Katz, G., *A systematic review and meta-analysis of published research data on COVID-19 infection fatality rates*, International Journal of Infectious Diseases, Vol. 101, P138-148, December 01, 2020, available at https://www.ijidonline.com/article/S1201-9712(20)32180-9/fulltext.

[12] Levin, A., *Assessing the Age Specificity of Infection Fatality Rates for COVID-19: Systematic Review, Meta-Analysis, and Public Policy Implications* medRxiv 2020.07.23.20160895; doi: https://doi.org/10.1101/2020.07.23.2016089, available at https://www.medrxiv.org/content/10.1101/2020.07.23.20160895v7.

influenza pandemic, it would land at the top—the most severe end—of the scale. The CDC in 2017 defined influenza pandemics along a scale of transmissibility (from 1-5) and clinical severity (from 1-7). Based on the reproduction number and approximately half of infections being symptomatic, COVID-19 would exceed the specifications for the highest transmissibility category (R0 > 1.8) (for COVID-19 R0 is thought to be at least 2[13] and up to 6 in some places[14]). It would also likely exceed the specification for the highest clinical severity category, which is a case-fatality ratio of 1% or more.[15] (Given the underascertainment of infections relative to cases, this criterion would be satisfied by an observed infection-fatality ratio of well under 1%, consistent with even the downwardly biased estimates of Dr. Ioannidis.) In short, the COVID-19 pandemic is at the upper end, and arguably at the very top, of the severity scale for influenza pandemics. It was for those pandemics that community mitigation strategies based on nonpharmaceutical interventions have been planned at the federal[16] and state[17] levels. A decade or more of pandemic planning envisioned exactly the kinds of measures being challenged by the defendants in response to a pandemic of a similar viral infection, even with lower severity than COVID-19.

23. In every pandemic, decisions about control must be made before comprehensive evidence is available on the characteristics of the infection in affected populations.[18] Evidence-

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[13] CDC, *COVID-19 Pandemic Planning Scenarios*, available at https://www.cdc.gov/coronavirus/2019-ncov/hcp/planning-scenarios.html.

[14] Sanche, S., et al., *High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2*, Emerg Infect Dis. 2020;26(7):1470-1477, available at https://wwwnc.cdc.gov/eid/article/26/7/20-0282_article.

[15] Qualls, N., et al., *Community Mitigation Guidelines to Prevent Pandemic Influenza — United States, 2017*, Recommendations and Reports / April 21, 2017 / 66(1);1–34 (Table 6), available at https://www.cdc.gov/mmwr/volumes/66/rr/rr6601a1.htm.

[16] Qualls (2017), *supra*.

[17] California Governor’s Office of Emergency Services, *Statewide Concept of Operations for Pandemic Influenza*, available at https://www.caloes.ca.gov/PlanningPreparednessSite/Documents/StatewideConOpsforPandemicInfuenza%202009.pdf.

[18] Lipsitch, M., et al., *Managing and Reducing Uncertainty in an Emerging Influenza Pandemic*, N. Engl. J. Med. 2009; 361:112-115, doi: 10.1056/NEJMp0904380, available at https://www.nejm.org/doi/full/10.1056/nejmp0904380.

gathering and mitigation efforts must proceed in parallel.[19] Waiting for definitive evidence on severity, transmissibility, and other characteristics of the pathogen and the population before adopting control measures is not a viable option, because exponential or near-exponential spread of infection in new pandemics in highly susceptible populations can rapidly transform a small public threat into a large one, and the impact of control measures is often delayed. Thus, it is rational to take action to avert possible negative outcomes before there is certainty about the likelihood and timing of these outcomes. There is room for legitimate disagreement about the strength of evidence and the justification for particular control measures. Yet in the face of a growing pandemic with clear ability to cause severe illnesses, to kill, and to cause health care disruption, it would be irresponsible public health policy to await definitive evidence before taking control measures that are expected to blunt the impact of the pandemic. This was the very clear situation in March 2020 in the United States, as we watched the impact of the pandemic in other countries that had been struck earlier.[20] Indeed, there is a compelling argument in my view that many state authorities were too slow, not too fast, to impose restrictions to slow the spread of SARS-CoV-2 during the early months of 2020. On this view, California is a model, while other states deserve criticism for slower reactions.[21]

24. The actions taken by California's public health authorities appear to have reduced transmission. Not only do seroprevalence estimates indicate that the virus has been less widespread in California than other regions of the U.S.; but a recent analysis showed that states with stricter containment measures to reduce the spread of the virus—like California—had fewer new cases and

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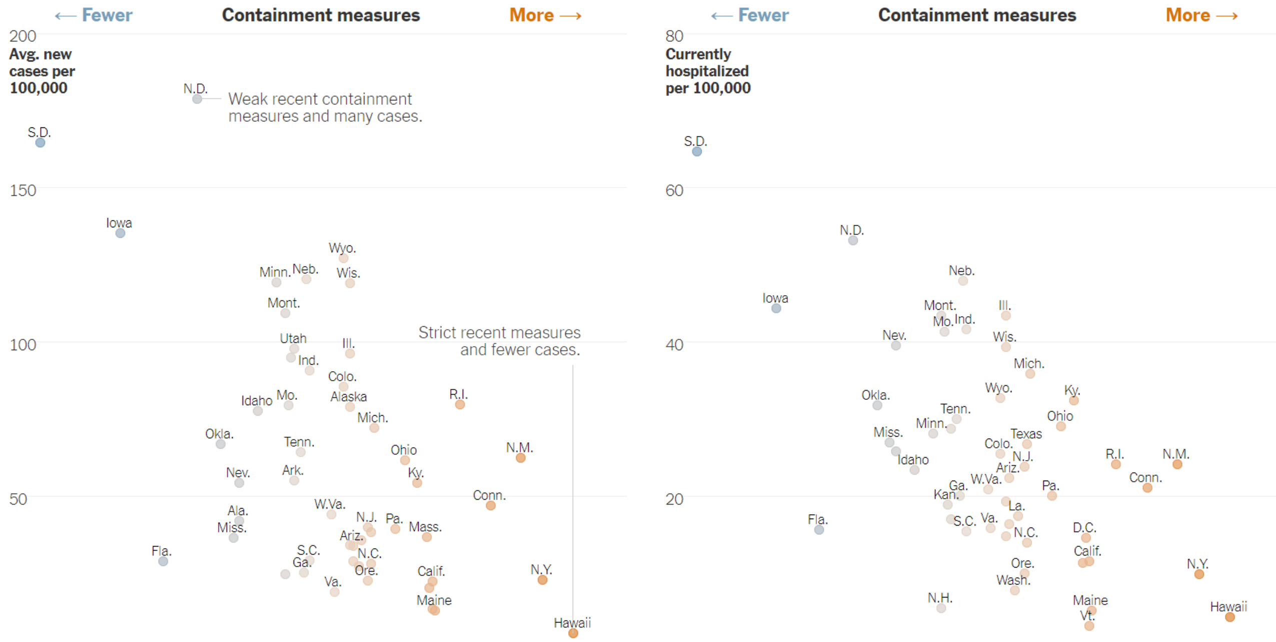
[19] Lipsitch, M., et al., for the 2009 H1N1 Surveillance Group. *Improving the Evidence Base for Decision Making During a Pandemic: The Example of 2009 Influenza A/H1N1*, 2011, Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and ScienceVol. 9, No. 2, available at https://www.liebertpub.com/doi/full/10.1089/bsp.2011.0007.

[20] Lipsitch, M., *We know enough now to act decisively against Covid-19. Social distancing is a good place to start*, March 18, 2020, STAT, available at https://www.statnews.com/2020/03/18/we-know-enough-now-to-act-decisively-against-covid-19/.

[21] Sexton, J., et al., *Two Coasts. One Virus. How New York Suffered Nearly 10 Times the Number of Deaths as California*, May 16, 2020, ProPublica, available at https://www.propublica.org/article/two-coasts-one-virus-how-new-york-suffered-nearly-10-times-the-number-of-deaths-as-california.

hospitalizations per capita than states that imposed few restrictions, which developed some of the worst outbreaks:[22]




Note: Cases and hospitalizations are data from Nov. 16. Containment measures are as of Nov. 1. Sources: Oxford Covid-19 Government Response Tracker, New York Times database of reports from state and local health agencies and hospitals

25. The size of the vulnerable population in the United States is large. Not only are there significant numbers of American over 65—according to the U.S. Census Bureau, about 16.5% of the population was 65 or over in 2019[23]—but the CDC estimates that nearly 50 percent of Americans live with underlying conditions that predispose them to serious outcomes from COVID-19.

26. Letting the virus spread unchecked in younger populations—which include Americans with underlying conditions—will result in more serious illness and deaths, in addition to increasing the risk of transmission to older populations.

**There Is No Proven Means To Protect The Vulnerable Without Restraining Transmission In The General Population**

27. No one has yet devised an effective approach to protecting vulnerable populations

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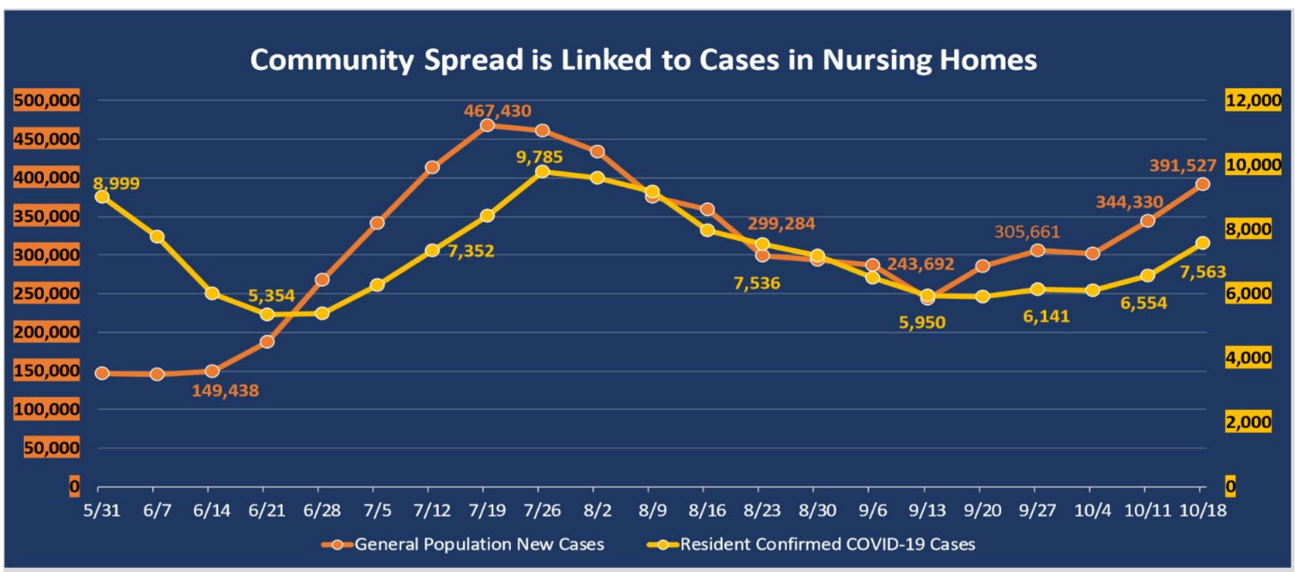
[22] Leatherby L., et al., *States That Imposed Few restrictions Now Have the Worst Outbreaks*, New York Times, Nov. 18, 2020, available at https://www.nytimes.com/interactive/2020/11/18/us/covid-state-restrictions.html?action=click&module=RelatedLinks&pgtype=Article.

[23] U.S. Census Bureau, https://www.census.gov/data/tables/time-series/demo/popest/2010s-national-detail.html (accessed Nov. 9, 2020).

when there is widespread community transmission. Vulnerable individuals—including older Americans and those with pre-existing conditions—live and work with, and receive care from, members of the larger community. Many of the vulnerable live in a multigenerational home, are cared for by others in nursing and long-term care facilities, and/or are essential workers with comorbidities; and these individuals cannot be completely isolated from the larger community. Nonetheless, scientists, clinicians, and policy makers have been working hard to protect these groups, with little or modest success, for most of the year, while also attempting to minimize the threat that community transmission poses to them and to all of us. This "belt-and-suspenders" approach is the current consensus approach among infectious-disease epidemiologists.

28. Reducing or eliminating community transmission is critical to protecting vulnerable populations, including those in long-term care facilities. The American Health Care Association (AHCA) and the National Center for Assisted Living (NCAL) recently released a report stating that COVID-19 cases in U.S. nursing homes have risen with the community spread of COVID-19 since mid-September.[24] That report explicitly links cases in nursing homes to community spread of the virus:



Sources: Centers for Medicare & Medicaid Services (CMS), May 31 – October 18 on Nursing Home COVID Cases and Johns Hopkins on COVID Cases in General Population

[24] AHCA and NCAL, *Report: COVID-19 Cases In U.S. Nursing Homes*, updated Nov. 2, 2020, available at https://www.ahcancal.org/News-and-Communications/Fact-Sheets/FactSheets/Report-Nursing-Homes-Cases-Nov2-2020.pdf (accessed Nov. 10, 2020).

29. Without reducing community transmission, strategies focused on protecting vulnerable populations are unlikely to succeed. Sweden, the best-known exemplar of the "age-targeted" approach, was unable to protect people in nursing homes. Ostensibly the goal in Sweden was to protect the elderly and other high-risk groups while slowing viral spread enough to avoid hospitals being overwhelmed; although it has been widely reported that the goal was in fact to develop herd immunity.[25] The strategy failed to meet its goal of protecting the elderly: the virus ran rampant in nursing homes, and Stockholm's nursing homes lost 7% of their residents. Sweden's polices are now falling back in line with its European neighbors.[26] Vulnerable individuals living in multigenerational households present a distinct challenge to "focused protection" in the absence of community control, particularly given that transmission of SARS-CoV-2 in households is common,[27] and households are the single greatest known source of transmission in many locales.[28]

30. The elderly, and nursing home residents in particular, are only a fraction of the truly vulnerable population. As noted above, over 52,000 deaths have occurred in those under 65 in the US, about 18% of the total death toll. Some comorbidities that predispose to severe outcomes, such as diabetes and certain cancers, may be invisible to those who are charged with protecting the vulnerable. Nonwhite race/ethnicity,[29] low socioeconomic status,[30] and other variables are also

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[25] Vogel, G., *'It's been so, so surreal.' Critics of Sweden's lax pandemic policies face fierce backlash*, Science, Oct. 6, 2020, available at https://www.sciencemag.org/news/2020/10/it-s-been-so-so-surreal-critics-sweden-s-lax-pandemic-policies-face-fierce-backlash; Bjorklund, K., *The Swedish COVID-19 Response Is a Disaster. It Shouldn't Be a Model for the Rest of the World*, Time, Oct. 14, 2020.

[26] Vogel 2020, *supra*.

[27] Grijalva, C., *Transmission of SARS-COV-2 Infections in Households — Tennessee and Wisconsin, April–September 2020*, Nov. 6, 2020, MMWR, 69(44);1631–1634.

[28] Bebinger, M., *Mass. Takes Close Look At Cluster Origins To Stop Coronavirus Spread*, WBUR, Oct. 20, 2020, https://www.wbur.org/commonhealth/2020/10/30/massachusetts-covid-cluster-data; *Infektionsumfeld von COVID-19-Ausbrüchen in Deutschland*, Epidemiologisches Bulletin, 38 2020, Sept. 17, 2020, https://www.rki.de/DE/Content/Infekt/EpidBull/Archiv/2020/Ausgaben/38_20.pdf;jsessionid=B8D1D66F6ECEC4B21EFDF40B78C8FB74.internet071?__blob=publicationFile.

[29] APM Research Lab, *The color of coronavirus: COVID-19 deaths by race and ethnicity in the U.S.*, Oct. 15, 2020, available at https://www.apmresearchlab.org/covid/deaths-by-race.

[30] Finch, W., et al., *Poverty and Covid-19: Rates of Incidence and Deaths in the United States During the First 10 Weeks of the Pandemic*, Front. Sociol., June 15, 2020, available at https://www.frontiersin.org/articles/10.3389/fsoc.2020.00047/full.

associated with high vulnerability to severe outcomes, making the logistics of "shielding the vulnerable" even more challenging.

31. Until we have a proven means to protect those most at risk and put those safeguards in place, it would be reckless to remove the protections against unmitigated community transmission and plunge ahead in pursuit of herd immunity via massive infection rates. Reducing community transmission remains one of the best ways to protect vulnerable populations.

**Any Herd Immunity May Be Short-Lived And Partial**

32. In the modern era, herd immunity is best achieved by vaccination—that is, when enough people acquire immunity to an infection through a shot in the arm to protect the whole community. That is our public health goal every flu season; and it is the reason we vaccinate infants against many childhood diseases.

33. The "herd immunity with focused protection" approach that Dr. Bhattacharya champions is to allow the spread of COVID-19 in younger populations in order to create immunity against later infection—the theory being that previously infected individuals will carry COVID-19 antibodies that will prevent reinfection. If carrying COVID-19 antibodies confers immunity, then half[31] or more[32] of the population must be seropositive—*i.e.*, COVID-19 antibody carriers—before we can control the virus without special measures, such as face coverings, social distancing, surveillance, and contact tracing.

34. It is possible that letting the virus spread uncontrolled in the younger population will build up some level of herd immunity and reduce further spread—for some period of time and with the significant cost of serious illness and death discussed above. However, the process of building up heard immunity could take a significant amount of time. The length of the pandemic could be 18

[31] Britton, T., et al., *A mathematical model reveals the influence of population heterogeneity on herd immunity to SARS-CoV-2*, Science 14 Aug 2020; 846-849.

[32] Sanche S, et al.. *High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2*. Emerg Infect Dis. 2020;26(7):1470-1477. https://dx.doi.org/10.3201/eid2607.200282.

to 24 months or more, as herd immunity gradually develops in the human population.[33] The serosurveillance data available to date suggests that a relatively small fraction of the population has been infected and infection rates likely vary substantially by geographic area. In late September 2020, CDC Director Robert Redfield told Congress that over 90 percent of the U.S. population remains susceptible to this coronavirus,[34] citing published data.[35] Another recent seroprevalence study estimated that that the percentage of people exposed to the virus ranged from 1% to 23% depending on jurisdiction, and that overall less than 10% of people had detectable SARS-CoV-2 antibodies.[36] Given the transmissibility of SARS-CoV-2, half to two-thirds of the population may need to be immune to reach a critical threshold of herd immunity to halt the pandemic.[37]

35. Unfortunately, however, coronavirus immunity is notoriously short-lived and partial. Other coronaviruses are called "seasonal" because, like the flu, they circulate every year. Based on seasonal coronaviruses, we can anticipate that even if immunity declines after exposure, there may still be some protection against disease severity and reduced contagiousness, but this remains to be assessed for SARS-CoV-2.[38] As a result, widespread infection in the general population is unlikely to eliminate the disease, but will more likely result in a persistent problem until an effective vaccine is available and widely adopted.

36. The quality of the seroprevalence studies conducted to date has varied widely, as have their results. The widely varying results of early seroprevalence studies emphasized the very local nature of the pandemic. For example, in a study that received extensive criticism for its sampling

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[33] Moore 2020, *supra*.

[34] C-SPAN, *CDC Director Redfield Says 90% U.S. Population Susceptible to Coronavirus Infection, Sept. 23, 2020*, https://www.c-span.org/video/?c4909117/cdc-director-redfield-90-us-population-susceptible-coronavirus-infection.

[35] Anand, S., et al., *Prevalence of SARS-CoV-2 antibodies in a large nationwide sample of patients on dialysis in the USA: a cross-sectional study*, The Lancet, Vol. 396, Issue 10259, pp. 1335-1344, October 24, 2020, DOI: https://doi.org/10.1016/S0140-6736(20)32009-2.

[36] Bajema K. et al., *Estimated SARS-CoV-2 Seroprevalence in the US as of September 2020*, JAMA Intern Med. (published online Nov. 24, 2020), doi:10.1001/jamainternmed.2020.7976.

[37] Britton 2020, *supra*; Sanche 2020; *supra*.

[38] Moore 2020, *supra*.

methods, statistics, and biased interpretation of the data obtained,[39] Dr. Bhattacharya and his co-authors found that 1.5 percent of Santa Clara County's population sampled tested positive for antibodies in the spring of 2020.[40] Other locales—in studies reflecting different kinds of imperfections in sampling—have shown much more widespread evidence of past infection, including 21 percent of those tested in New York City[41] and nearly a third in Chelsea, Massachusetts in April 2020.[42]

37. More recent national studies have continued to show regional variation in seroprevalence. The CDC conducted a commercial laboratory seroprevalence survey using blood samples collected from 10 U.S. sites from March to July 2020. The surveys estimated seroprevalence of 0.7% (San Francisco Bay Area) to as high as 23.2% (New York City Metro Area).[43] Another seroprevalence study of dialysis patients estimated that during the first wave of the COVID-19 pandemic, fewer than 10% of the U.S. adult population formed antibodies against SARS-CoV-2, with large regional variances.[44] In California, the study estimated seroprevalence of 3.8%.[45] The low seroprevalence estimates in California and the Bay Area suggest both that those regions have been more successful in limiting community transmission and that any measure of herd immunity is a distant prospect.

**Risks of Indoor Gatherings**

38. SARS-CoV-2 spreads through contact (via larger droplets and aerosols), and longer-

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[39] Vogel, G., *Antibody surveys suggesting vast undercount of coronavirus infections may be unreliable*. Science, Apr. 21, 2020, https://www.sciencemag.org/news/2020/04/antibody-surveys-suggesting-vast-undercount-coronavirus-infections-may-be-unreliable.

[40] Bendavid, E., et al., *COVID-19 Antibody Seroprevalence in Santa Clara County, California*, medRXiv, doi: https://doi.org/10.1101/2020.04.14.20062463.

[41] Goodman, J., et al., *1 in 5 New Yorkers May Have Had Covid-19, Antibody Tests Suggest*, https://www.nytimes.com/2020/04/23/nyregion/coronavirus-antibodies-test-ny.html.

[42] Saltzman, J., *Nearly a third of 200 blood samples taken in Chelsea show exposure*, Boston Globe, Apr. 17, 2020, https://www.bostonglobe.com/2020/04/17/business/nearly-third-200-blood-samples-taken-chelsea-show-exposure-coronavirus/.

[43] CDC, *Commercial Laboratory Seroprevalence Surveys,* https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/commercial-lab-surveys.html#surveymap

[44] Anand 2020, *supra*.

[45] *Id*.

range transmission via aerosols, especially in conditions where ventilation is poor. This makes large, indoor gatherings particularly high-risk activities for transmission of the virus, especially where mitigation measures like the use of face coverings and social distancing are not being observed. I understand that the plaintiffs in this lawsuit have stated that they are holding church services of more than 800 people indoors, without requiring face coverings and social distancing, and while permitting singing. These circumstances present a relatively high risk of transmission.

39. A number of factors make plaintiffs' conduct particularly high risk. First, longer duration contacts increase the risk of transmission. For direct interpersonal interactions—that is, close contact without social distancing—the risk of transmission is proportional to the duration of the interaction. Longer duration contacts create a higher risk of transmission. Epidemiologists often distinguish between contacts below fifteen minutes (lower risk) and at or beyond fifteen minutes (higher risk)—hence the "fifteen-minute rule." For viruses like SARS-CoV-2 that are spread though respiratory droplets and aerosols, microbial risk assessment experts use estimates of breathing rates and duration of exposure to develop control strategies to reduce transmission.[46] Models of COVID-19 transmission using cell phone mobility data identify locations associated with longer duration indoor contacts—including full-service restaurants and religious organizations—as producing the largest predicted increases in infections when reopened.[47]

40. The aerosol component of COVID-19 transmission would also be expected to increase this risk of transmission over time. Simply stated, the longer people are in an enclosed space, the more viral particles will build up and be available to infect others. The amount of virus per liter of air will depend on a number of factors, including the size of the space, the number of people in that space, and the frequency of air changes. For these reasons, more crowded gatherings and poor ventilation would both be expected to increase the risk of transmission in an indoor space.

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[46] Hass C, *Action Levels for SARS-CoV-2 in Air: Preliminary* Approach, Preprint (Aug. 14, 2020).

[47] Chang S, et al., *Mobility network models of COVID-19 explain inequities and inform reopening*. Nature (2020), doi: https://doi.org/10.1038/s41586-020-2923-3.

41. Second, larger gatherings in indoor spaces increase the risk of transmission both for the reasons explained above, and because the larger the gathering, the more likely that infectious individuals will in fact be present, depending on the prevalence of the disease in the community.

42. Third, singing is a well-described risk factor for transmitting respiratory disease.[48] Dr. Bhattacharya's opinion that the defendants can "safely" hold indoor services that include "singing and chanting" (Para. 21) does not appear to consider the research on singing. It is understood that singing, chanting, shouting, and similar vocalizations can cause the release of a larger number of virus-bearing respiratory droplets and aerosols and may also increase the distance that droplets or aerosolized particles can travel compared to speaking at a normal volume. There are documented COVID-19 outbreaks where singing is presumed to have been a factor, including one involving a choir practice in Skagit County, Washington.[49] I understand that the plaintiffs have been permitting singing at their services. This would increase the risk of transmission, especially where mitigation measures including face coverings and social distancing are not being enforced. Public health measures to limit or prohibit indoor singing, chanting, shouting, and similar vocalizations, would decrease the risk of transmission of COVID-19, which is principally spread by respiratory droplets and aerosols.

43. While face coverings and social distancing would mitigate the risk of COVID-19 transmission from singing indoors, it would not eliminate that risk. Accordingly, it is not accurate to call singing a "safe" indoor activity at a multi-household gathering, especially where the use of face coverings and social distancing are not required.

44. Dr. Bhattacharya states in his declaration that he has reviewed the CDC's May 23, 2020 guidance titled "Considerations for Communities of Faith." The current version of that

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[48] Buonanno G., et al., *Quantitative assessment of the risk of airborne transmission of SARS-CoV-2 infection: Prospective and retrospective applications*, Environ Int. (2020) Sep. 6;145:106112, doi: 10.1016/j.envint.2020.106112.

[49] Hamner, L., *High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice - Skagit County, Washington*, March 2020. Morbidity and Mortality Weekly Report 69.

guidance was updated on October 29, 2020.[50] The CDC offers this guidance to faith communities "in the course of preparing to reconvene for in-person gatherings while still working to prevent the spread of COVID-19." As this prefatory statement indicates, the CDC guidance begins with the understanding that many faith communities have not been gathering during the pandemic and provides instructions on how to begin to gather again safely. The first point in the guidance under the heading "Scaling Up Operations," advises faith communities to "[e]stablish and maintain communication with local and State authorities to determine current mitigation levels in your community." In response to the current surge in COVID-19 cases and the pressure on hospital resources and ICU capacity in California and Santa Clara County in particular, it is my understanding that the current mitigation measures prohibit indoor gatherings, including church services. I do not understand the CDC's guidance to instruct faith communities to ignore or act contrary to the current local mitigation strategy.

45. The CDC recently published a *Summary of Guidance for Public Health Strategies to Address High Levels of Community Transmission of SARS-CoV-2 and Related Deaths*.[51] That guidance lists recommended public health strategies as well as recommendations for community-level implementation. The guidance recommends the "universal use of face masks" as a public health strategy, and for that strategy recommends the following community-level implementation: "Issue policies or directives mandating universal use of face masks in indoor (nonhousehold) settings." The CDC guidance also recommends "[a]void[ing] nonessential indoor spaces and crowded outdoor settings" as a public health strategy, and for that strategy recommends the following community-level implementation: "Promoting flexible worksites (e.g., telework); apply limits to occupancy of indoor spaces and to the size of social gatherings." In my view, these are critical national and local strategies to mitigate the risk of COVID-19 transmission.

46. Any region experiencing moderate, high, or increasing levels of community

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[50] CDC, *Considerations for Communities of Faith*, updated Oct. 29, 2020, available at https://www.cdc.gov/coronavirus/2019-ncov/community/faith-based.html (visited Dec. 12, 2020).

[51] Honein M., et al., *Summary of Guidance for Public Health Strategies to Address High Levels of Community Transmission of SARS-CoV-2 and Related Deaths*, December 2020. MMWR Morb Mortal Wkly Rep 2020;69:1860-1867, doi: http://dx.doi.org/10.15585/mmwr.mm6949e2.

transmission should do everything possible to lower transmission. The path to low transmission in other countries has included adherence to stringent community control measures—including closure of nonessential indoor work and recreational spaces.[52] Such measures along with universal mask wearing (with specific exceptions[53]) are essential to bring case numbers down to safe levels for communities to reopen.[54]

47. The United States is in the midst of a large surge in cases, recording over 200,000 new cases and more than 3,000 deaths per day. These levels of transmission threaten to overwhelm hospitals and ICU capacity in many areas. As the CDC reported last week, all age groups have reached their highest weekly hospitalization rate since the start of the pandemic, with those rates expected to increase as additional data are reported.[55] And ICU capacity is dwindling in many areas, including Santa Clara County, where ICU beds have been filling up and available capacity has dropped from around 25% to under 15% in the past month.[56] Given these circumstances, it would be reckless to lift restrictions on community transmission, for example, by permitting the large, mask-optional, indoor gatherings that plaintiffs want to hold.

48. "Flatten the curve" was a good idea when the world first heard the concept in March, and it is a particularly good one right now. A flatter curve, with more infections delayed, will help the health-care system better cope with the cases it does have. Whereas an overwhelmed health-care system will mean there is little reserve to care for the seriously ill, including all the other diseases

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[52] Couzin-Frankel J, Vogel G, Weiland M., *School openings across globe suggest ways to keep coronavirus at bay, despite outbreaks*, American Association for the Advancement of Science. July 7, 2020, available at https://www.sciencemag.org/news/2020/07/school-openings-across-globe-suggest-ways-keep-coronavirus-bay-despite-outbreaks.

[53] CDC, *Coronavirus Disease 2019 (COVID-19), Frequently Asked Questions*, available at https://www.cdc.gov/coronavirus/2019-ncov/faq.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fneed-extra-precautions%2Fpeople-with-seasonal-allergies-faqs.html#People-with-Seasonal-Allergies.

[54] Levinson, M., *Reopening Primary Schools during the Pandemic* (2020) N. Engl. J. Med. 2020; 383:981-985, DOI: 10.1056/NEJMms2024920.

[55] CDC, COVIDView, *Key Updates for Week 49, ending December 5, 2020*, available at https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covidview/index.html.

[56] Santa Clara County Public Health Department, COVID-19 Hospitalizations Dashboard, available at https://www.sccgov.org/sites/covid19/Pages/dashboard-hospitals.aspx.

hospitals were created to treat. Finally, the first vaccine is here, and more vaccines appear to be on their way. These vaccines appear to be effective enough to protect us, if we can stay uninfected long enough to get our shots.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed at Jamaica Plain, Massachusetts on December 13, 2020.

*<u>/s/ Marc Lipsitch</u>*
MARC LIPSITCH

2322567

# Exhibit A

# CURRICULUM VITAE

| | |
|---|---|
| DATE: | October 9, 2020 |
| NAME: | Marc Lipsitch |
| ADDRESS: | Department of Epidemiology<br>Harvard T.H. Chan School of Public Health<br>677 Huntington Avenue<br>Boston, MA 02115 |
| DATE & PLACE OF BIRTH: | November 15, 1969, New Haven, CT, USA |

EDUCATION:

| *Date* | *Discipline* | *Degree* | *Institution* |
|---|---|---|---|
| 1991 | Philosophy | B.A. *summa cum laude* | Yale University |
| 1995 | Zoology | D.Phil. | University of Oxford |

POSTDOCTORAL TRAINING:

| | | | |
|---|---|---|---|
| 1995-1999 | Biology | Postdoc with Dr. Bruce Levin | Emory University |

ACADEMIC APPOINTMENTS:

| | |
|---|---|
| 1997-1999 | Visiting Scientist, Respiratory Diseases Immunology Section, Centers for Disease Control and Prevention |
| 1999-2004 | Assistant Professor, Department of Epidemiology, Harvard School of Public Health |
| 2004-2006 | Associate Professor, Department of Epidemiology and Department of Immunology and Infectious Diseases, Harvard School of Public Health |
| 2006-present | Professor, Department of Epidemiology and Department of Immunology and Infectious Diseases, Harvard School of Public Health |
| 2009-present | Director, Center for Communicable Disease Dynamics, Harvard School of Public Health |
| 2009-present | Associate Member, Broad Institute, Cambridge, MA |
| 2012-2018 | External Faculty Member, Santa Fe Institute, Santa Fe, NM |

HONORS AND DISTINCTIONS:

| | |
|---|---|
| 1991 | Phi Beta Kappa, Yale College |
| 1992-1995 | Rhodes Scholar, University of Oxford, England |
| 2002 | Ellison Medical Foundation New Scholar in Global Infectious Disease |
| 2002 | PhRMA Foundation Research Starter Award in Health Outcomes |
| 2002 | ICAAC Young Investigator Award, American Academy of Microbiology |
| 2006 | Mentoring Award, Harvard School of Public Health |
| 2009 | Thompson Science Hall of Fame, Westminster Schools, Atlanta, GA |
| 2011 | Kenneth Rothman Award, Best Paper in *Epidemiology* in 2010 |
| 2012 | Junior Faculty Mentoring Award, Harvard School of Public Health |
| 2013 | Reviewer of the Year in *Epidemiology* in 2012 |
| 2014 | Member, winning team (PI Shaman), CDC Predict the Influenza Season Challenge |
| 2015 | Elected Fellow, American Academy of Microbiology |
| 2016 | Robert Austrian Lecturer, International Symposium on Pneumococci and Pneumococcal Diseases |
| 2018 | 2017 Article of the Year, American Journal of Epidemiology |
| 2019 | 23rd Annual Robert M. Fekety, Jr., MD Lecturer, University of Michigan |
| 2020 | Elected Member, National Academy of Medicine |

PROFESSIONAL SERVICE:

| | |
|---|---|
| 1999 | Temporary Advisor, WHO. Priorities for Pneumococcal and Hib Vaccine Development and Introduction. Geneva, Switzerland |
| 2000, 2002 | National Institutes of Health, National Center for Research Resources, Special Emphasis Panel, Centers of Biomedical Research Excellence |
| 2001-2003 | Consultant and invited speaker for three public meetings, FDA Center for Veterinary Medicine. Topic: regulation of antimicrobial drugs in veterinary medicine |
| 2002 | Member, WHO Pneumococcal Vaccine Trials Nasopharyngeal Carriage Study Group |
| 2003 | Member, WHO Working Group on SARS Epidemiology and Modeling |
| 2003-2004 | US Department of Defense, Defense Science Board Task Force on SARS Quarantine |
| 2005 | Consultant, Ministry of Foreign Affairs, Canada – Pandemic Influenza |
| 2005 | Consultant, Congressional Budget Office – Pandemic Influenza |
| 2006, 2007 | National Institutes of Health Study Section on Genetic Variation and Evolution |
| 2007, 2008, 2012 | National Institutes of Health Special Emphasis Panels, various |
| 2007-2011 | Report reviewer, National Research Council, NEIDL Risk Assessments |
| 2008 | Food and Drug Administration, Antiviral Advisory Committee, guest member |
| 2008-2009 | Member, World Economic Forum Global Agenda Council on Pandemics |
| 2009 | Consultant, Mexico Ministry of Health, Pneumococcal Conjugate Vaccine |
| 2009 | US President's Council of Advisors on Science and Technology (PCAST)--H1N1 Working Group |
| 2009 | Massachusetts Department of Public Health H1N1 Advisory Group |
| 2009-2010 | Team B Advisory Body to CDC on Novel H1N1 Influenza |

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| 2010-2013 | Member, Informal Advisory Group on 2009 Pandemic Influenza Mortality, WHO |
| 2010- | Member, Pneumococcal Serotype Replacement Technical Advisory Group, WHO |
| 2011- | Member, Scientific Advisory Board, Pneumococcal Global Sequencing Project (Gates Foundation, Keith Klugman, PI) |
| 2014-2016 | Member, CIDRAP/Wellcome Trust Team B on Ebola Vaccines |
| 2015 | Member, Scientific Advisory Group, Norwegian Institute of Public Health/WHO/MSF Ebola Virus Vaccine Trial |
| 2015 | Member, Scientific Review Committee, Wellcome Trust Sanger Institute 5-Year Review (4-day evaluation visit) |
| 2017- | Member, Biological Agents Containment Working Group, Board of Scientific Counselors, Office of Public Health Preparedness and Response, CDC |
| 2018- | Member, Advisory Board, Vaccines and Immunotherapies, CARB-X |
| 2018- | Member, Technical Advisory Group, Pneumococcal Serotype Replacement and Distribution Project (PSERENADE), International Vaccine Action Center |
| 2019- | Co-chair, WHO Working Group on Vaccines and Antimicrobial Resistance (VAC-AMR) |
| 2019 | Member, Steering Committee, Scorecard on Progress on Recommendations of the Review of Antimicrobial Resistance, Chatham House |
| 2020 | Member, Massachusetts Governor's Medical Advisory Committee |
| 2020 | Member, Massachusetts COVID-19 Vaccine Working Group |
| 2020 | Ad hoc expert, WHO Strategic Advisory Group of Experts, COVID-19 Vaccine Working Group |

EDITORIAL BOARDS:

| | |
|---|---|
| 2002-2012 | Associate Editor, *American Journal of Epidemiology* |
| 2004-2008 | Associate Faculty Editor, *Emerging Themes in Epidemiology* |
| 2009-2010 | Member, Faculty of 1000 Biology |
| 2006-2016 | Editorial Board, *PLoS Medicine* |
| 2008-2011 | Associate Editor, *Epidemics* |
| 2008-2011 | Editorial Board, *Emerging Health Threats* |
| 2009-2010 | Board of Editorial Advisors, *Journal of Infectious Diseases* |
| 2009-present | Editorial Board, *Epidemiology* |
| 2015-present | Board of Reviewing Editors, *eLife* |

PROFESSIONAL SOCIETIES:

Society for Epidemiologic Research
American Society for Microbiology
National Center for Science Education
Union of Concerned Scientists

PUBLIC HEALTH ORGANIZATIONS:

Founder, Cambridge Working Group, 2014
Founder, Society for Safe Science, 2014

SCIENTIFIC COMMITTEES AND CONFERENCE ORGANIZING:

Scientific Committee: 4th International Symposium on Pneumococci and Pneumococcal Diseases, Helsinki, Finland, May 2004
Scientific Committee: 5th International Symposium on Pneumococci and Pneumococcal Diseases, Alice Springs, Australia, May 2006
Scientific Committee: 6th International Symposium on Pneumococci and Pneumococcal Diseases, Reykjavik, Iceland, June 2008
Scientific Committee: 7th International Symposium on Pneumococci and Pneumococcal Diseases, Tel Aviv, Israel, March 2010
Scientific Committee: 9th International Symposium on Pneumococci and Pneumococcal Diseases, Hyderabad, India, March 2014
Conference Chair: First Annual Center for Communicable Disease Dynamics Symposium: Surveillance for Decision Making in Emerging Diseases: Lessons from the 2009 H1N1 Pandemic Influenza. Boston, June 2010
Organizing Committee: Epistemology of Modeling and Simulation. University of Pittsburgh, April 2011.
Conference Chair: Second Annual Center for Communicable Disease Dynamics Symposium: Antimicrobial Resistance: Biology, Population Dynamics and Policy Options. Boston, October 2011
Conference Chair: Epidemics$^3$, Boston, November 2011
Scientific Committee: Epidemics$^4$, Amsterdam, November 2013
Conference organizer: Workshop on Modeling and Simulation for Infectious Disease Trial Design, Seattle, August 2016 (with Betz Halloran)
Workshop organizer: Ethical Design of Vaccine Trials in Emerging Infections, ETHOX, Oxford, UK, July 2017 (with Rebecca Kahn, Nir Eyal, Annette Rid)
Scientific Committee: 12th International Symposium on Pneumococci and Pneumococcal Diseases, Toronto, 2020
Advisory group on COVID-19, Science Philanthropy Alliance, August 2020

GRANT REVIEWER SINCE 2003:

Research Fund for the Control of Infectious Disease (RFCID), Hong Kong Semi-Autonomous Region, China
UK Medical Research Council
Wellcome Trust (UK)
Department of Veterans Affairs, USA
Alliance for the Prudent Use of Antibiotics
Swiss National Science Foundation
RIVM (National Institute of Health and Environment), Netherlands
Innovational Research Incentives Scheme, Royal Netherlands Academy of Sciences
National Institutes of Health, ad hoc member, GVE study section (4x), IRAP study section (1x), several telephone special review groups
Health Research Council of New Zealand

AXA Foundation Fellowships
Canadian Institutes of Health Research
Royal Society of New Zealand
French National Research Agency (ANR)
Royal Society (UK)
NIH Special Emphasis Panels (2013/01 ZRG1 IDM-A (02) S; 2014/08 ZRG1 RPHB-W (53) R - RFA-RM-13-009: NIH Director's Early Independence Awards Review)
Dutch Research Council NOW (2011, 2017)
NIH Special Emphasis Panel (2014/10 ZRG1 IDM-S (02) M)
Chair of NIH Infectious Diseases and Microbiology Integrated Review Group, ZRG1 IDM S02 10/2014 council
NIH CRFS Study section, ad hoc member, 2015
UK Medical Research Council (2016)

INVITED TALKS (SINCE 2015):

| | |
|---|---|
| 01/2015 | Otto Wolff Lecture, Institute of Child Health, University College London |
| 01/2015 | London School of Hygiene and Tropical Medicine, invited lecture |
| 01/2015 | Centre for the Study of Existential Risk, Cambridge University, UK, invited lecture |
| 02/2015 | Public Health England, Colindale, London UK, invited lecture |
| 03/2015 | London School of Hygiene and Tropical Medicine, Health Protection Research Unit Annual Conference, Invited Lecture |
| 04/2015 | University of Bristol Department of Social Medicine |
| 04/2015 | University of Pittsburgh Marcella L. Finegold Memorial Public Debate Series |
| 05/2015 | Applied Bioinformatics and Public Health Conference, Wellcome Trust Sanger Institute, Keynote Lecture |
| 06/2015 | Médecins sans Frontières Science Day, Panel Discussion, Paris, France |
| 06/2015 | Eijkman Lecture, UMC Utrecht, Netherlands |
| 07/2015 | ETH Zurich Latsis Symposium, plenary talk |
| 07/2015 | Jenner Lecture, Jenner Vaccine Institute, Oxford University, UK |
| 09/2015 | [popular presentation] HubWeek *Four Global Health Threats, Four Global Health Opportunities,* Harvard University |
| 01/2016 | National Science Advisory Board on Biosecurity |
| 02/2016 | WHO Technical Expert Consultation: Alternate Dosing Schedules of Pneumococcal Conjugate Vaccines, Geneva (by videolink) |
| 02/2016 | PATH Scientific Advisory Board, PATHwSP Vaccine Trial, Geneva (by videolink) |
| 05/2016 | Department of Microbiology and Immunology, Emory University, Atlanta |
| 05/2016 | Causal Inference in the Presence of Interference, Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, MA |
| 06/2016 | Robert Austrian Award Lecture, International Symposium on Pneumococci and Pneumococcal Diseases-10 |
| 07/2016 | Glaxo SmithKline Vaccines, Rockville, MD |
| 07/2016 | White House Pandemic Prediction and Forecasting Science and Technology Working Group (PPFST WG) |

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|---|---|
| 09/2016 | Keynote Address, Project Prometheus Workshop on Multi-Strain Modeling, RIVM (National Institute of Public Health and the Environment), Bilthoven, Netherlands |
| 01/2017 | Postdocs in Complexity Conference, Santa Fe Institute, NM (not delivered due to travel delays) |
| 02/2017 | Department of Epidemiology of Microbial Diseases, Yale School of Public Health, New Haven, CT |
| 03/2017 | Department of Mathematics, University of Utah |
| 03/2017 | The Value of Vaccines in the Avoidance of Antimicrobial Resistance, Chatham House, London |
| 03/2017 | WHO Workshop on Vaccines and Antimicrobial Resistance, London, UK |
| 04/2017 | National Math Festival, Washington, DC (two talks) |
| 05/2017 | Memorial Symposium for Ellis McKenzie, Fogarty International Center, NIH, Bethesda, MD |
| 06/2017 | EA Global, Society for Effective Altruism, Cambridge, MA |
| 06/2017 | Panelist, Surveillance workshop, Simons Foundation, New York, NY |
| 09/2017 | Emerging Leaders in Biosecurity meeting, Johns Hopkins Center for Health Security (held Cambridge, MA) |
| 12/2017 | Risk in Complex Systems: Models, Applications, Perceptions, and Policy Implications, Centre de Recherches Mathematiques, University of Montreal |
| 3/2018 | Department of Ecology and Evolutionary Biology, Princeton University |
| 3/2018 | 17th Annual Symposium, Institute for Systems Biology, Seattle |
| 4/2018 | Gates Vaccine Impact Modeling Consortium, Keynote Address, annual meeting in Cambridge, MA |
| 5/2018 | ”Antibiotic resistance: Evolutionary concepts versus clinical realities,” Wenner-Gren Center, Stockholm |
| 6/2018 | London School of Hygiene and Tropical Medicine |
| 6/2018 | Institut Pasteur, Paris |
| 6/2018 | Big Data Institute, University of Oxford |
| 8/2018 | PRISM (Policy relevant infectious disease simulation and mathematical modelling) Annual Meeting, Palm Cove, Australia |
| 8/2018 | David Danks Seminar, Murdoch Children’s Research Institute, Melbourne, Australia |
| 11/2018 | Berkman-Klein Center, Harvard Law School, Data and Health Seminar |
| 6/2019 | Chan-Zuckerberg Biohub, San Francisco |
| 6/2019 | Stanford Medical School, Stanford, CA |
| 6/2019 | Proctor Foundation, UC San Francisco, CA |
| 7/2019 | Wellcome Meeting on the Global Burden of Disease from Antimicrobial Resistance, London |
| 10/2019 | 23rd Annual Robert M. Fekety, MD Lecture, Department of Medicine, Division of Infectious Diseases, University of Michigan |
| 10/2019 | Microbiology and Infectious Diseases Seminar, University of Geneva, Switzerland |
| 3/2020 | National Academy of Medicine/American Public Health Association First Webinar on COVID-19, Washington DC (via Zoom) |
| 3/2020 | Harvard Kennedy School Growth Lab, Cambridge, MA (via Zoom) |
| 3/2020 | White House Modeling Consortium, Washington DC (via Zoom) |
| 4/2020 | European Central Bank (via Zoom) |
| 4/2020 | *USA Today* Editorial Board (via Zoom) |
| 4/2020 | *New York Times* Editorial Board (via Zoom) |

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| 4/2020 | Harvard Medical School Department of Medicine Grand Rounds (one of many short talks, via Zoom) |
| 5/2020 | Massachusetts Coalition for Pathogen Research (one of many short talks, via Zoom) |
| 5/2020 | Covid symposium, National Institute of Statistical Science/American Statistical Association |
| 5/2020 | Private briefing, Deputy Prime Minister Chrystia Freeman, Ottawa, Canada |
| 5/2020 | Briefing, New Democrat Coalition, by Zoom |
| 5/2020 | Isaac Newton Institute, Cambridge University, UK, by Zoom |
| 5/2020 | Futureproofing Public Health, University of Stellenbosch, by Zoom |
| 5/2020 | Private briefing, Rahul Gandhi, Leader, Congress Party, India |
| 5/2020 | Harvard Club of Boston, by Zoom |
| 5/2020 | Tsinghua University / AAAS Symposium, Beijing, by Zoom |
| 5/2020 | Institute for Genome Sciences, University of Maryland, by Zoom |
| 5/2020 | National Academy of Sciences, Section 43, by Zoom |
| 5/2020 | Medical Grand Rounds, Boston Children's Hospital, by Zoom |
| 5/2020 | Vaccine Research Center, Beth Israel Deaconess Medical Center, by Zoom |
| 5/2020 | COVID-19 and the Role of Modeling, American Statistical Association and the National Institute of Statistical Sciences (via Zoom) |
| 6/2020 | International Monetary Fund, by Zoom |
| 6/2020 | Webinarium: Role of a Medical University in a Pandemic, Karolinska Institutet, Stockholm, by Zoom |
| 7/2020 | Bipartisan Commission on Biosecurity, by Zoom |
| 7/2020 | National Bureau of Economic Research, by Zoom |
| 7/2020 | SAGE Working Group on COVID-19 Vaccines, by Zoom (panelist) |
| 7/2020 | Congressional Briefing on Human Challenge Trials, organized by 1DaySooner and Rep. Bill Foster, by Zoom |
| 7/2020 | International Symposium on Novel Ideas in Science and Ethics of Vaccines against COVID-19 Pandemic, India Council of Medical Research, by Zoom |
| 7/2020 | Private and Public Science, Advisory, and Consumer Food Policy Group (PAPSAC), Harvard Kennedy School, by Zoom |
| 8/2020 | National Academies (NASEM) Committee on Equitable Allocation of Vaccine for the Novel Coronavirus (panel), by Zoom |
| 8/2020 | Mathematical Sciences Research Institute, University of California, Berkeley, by Zoom |
| 8/2020 | Coronavirus Conversations, Science and Society, Duke University (panel), by Zoom |
| 8/2020 | Giving Pledge Meeting – Q&A with Scott Dowell, Bill and Melinda Gates Foundation, by Zoom |
| 8/2020 | Janelia Farm, Howard Hughes Medical Institute, via Zoom |
| 9/2020 | COVID-19, Public Health Ethics, and Policy for Pandemics, Harvard Medical School Center for Bioethics, Cambridge MA (via Zoom) |
| 9/2020 | From testing to distribution: the importance of, and challenges to, estimating the protective effects of vaccines, National Institute of Statistical Sciences, Research Triangle, NC (via Zoom) |
| 9/2020 | Epidemiology of COVID-19: Implications for Control, American Physical Society, College Park, MD (via Zoom) |

| | |
|---|---|
| 10/2020 | COVID-19 and Vaccines: Clinical Trials, Immunity and Immunization, American Lung Association, Chicago, IL (via Zoom) |
| 10/2020 | Board of Directors, Blue Cross-Blue Shield of Massachusetts |

## RESEARCH SUPPORT:

### Past Funding

| | |
|---|---|
| 1997-1999 | NIH postdoctoral fellowship 1 F32 GM019182 Population Genetics of Bacterial Infection and Treatment. Role: PI |
| 1997-1999 | SmithKlineBeecham unrestricted educational grant. Effects of Antiviral Usage on Resistance in Herpes Simplex Virus, Type 1. Bruce R. Levin, PI. Role: Co-PI |
| 2001-2005 | NIH research grant R01 AI051929. Drug Resistance in Tuberculosis: Genetics and Dynamics. Eric Rubin, PI. Role: Co-PI |
| 2001-2006 | NIH research grant R01 AI48935. Vaccination and the Evolutionary Dynamics of Pneumococci. Role: PI |
| 2001-2011 | NIH research grant R01 AI048935 Mechanisms of Capsular Diversity in *Streptococcus pneumoniae*. Role: PI |
| 2002 | PhRMA Foundation Research Starter Grant. Planning and Assessing Antimicrobial Cycling and Other Interventions to Control Resistance in Hospitals. Role: PI |
| 2002-2006 | Ellison Foundation New Scientist in Global Infectious Diseases Award. Antibiotic Resistance in *Streptococcus pneumoniae*: Transmission Dynamics and Consequences for Public Health. Role: PI |
| 2003-2006 | NIH research grant 5 R21 AI055825. Epidemiologic Methods: Resistant Nosocomial Infections. Role: PI |
| 2004-2013 | NIH/NIAID R01 AI058736 (Freedberg). Optimizing HIV care in less developed countries. Role: Consortium Co-Investigator |
| 2006 | Taplin Foundation Equipment Grant, Harvard School of Public Health. |
| 2006 | NIAID/TIGR Pathogen Functional Genomics Resource Center grant of access to free microarrays. Effects of Host Immunity on Pneumococcal Gene Expression. Role: PI |
| 2006-2009 | NIH cooperative agreement U01 GM076497. Methodological Approaches to Planning and Analysis of New Infectious Diseases. Role: PI. Replaced by U54 GM088558. |

| | |
|---|---|
| 2006-2016 | NIH/NIAID R01 AI066304 (Finkelstein). Conjugate Vaccine Impact of Pneumococcal Carriage, Disease, and Population (SPARC2). Role: Consortium PI |
| 2010-2014 | NIH/NIMH R01 MH087328 (Seage). Modeling the Impact of HIV Prevention Interventions (CEPAC Dynamic). Role: Co-PI |
| 2011-2016 | NIH/NIGMS R01 GM100467 (Shaman). Influenza Outbreak Prediction: Applying Data Assimilation Methodologies to Make Skillful Forecasts of an Inherently Chaotic, Nonlinear System. Role: Consortium PI |
| 2012-2018 | NIH/NIAID R01 AI048935-15 NCE. Mechanisms and Population Genomics of Pneumococcal Antigenic Diversity. Role: PI |
| 2013-2019 | NIH/NIGMS R01 AI106786-05 NCE (PI: Hanage). Ecological and Genetic Contributions to the Spread of Resistance in Pnumococcus. Role: Co-PI |
| 2014-2018 | Pfizer Inc. (No number). Modeling serotype replacement with Prevnar13 using an agent-based model (Phase 2). Role: PI |
| 2014-2018 | NIH/NIGMS R01 GM116525-03 (Seage). Calibration and Simulation of the Botswana Combination Prevention Project. Role: Co-PI |
| 2014-2018 | Program for Appropriate Technology in Health. 1773-00460733-COL. Modeling pneumococcal population dynamics under serotype-nonspecific vaccination. Role: PI |
| 2015-2018 | NIH/NIAID R21 AI112991-02 NCE (Huttenhower). Staphylococcus Aureus Carriage and the Nasal Microbiome. Role: Co-PI |
| 2015-2020 | NIH/NIGMS R01 GM113233 (Wargo). The impacts of host vaccination and selective breeding for disease resistance on pathogen transmission and ecology in freshwater aquaculture. Role: Consortium PI |
| 2017-2019 | Pfizer Inc. CP147216 (Lipsitch/Lewnard). Quantifying pneumococcal conjugate vaccine impact against otitis media. Role: Co-PI |
| 2017-2020 | CDC 1 U01 CK000538-01 (Samore). Modeling and simulation to support antibiotic stewardship and epidemiological decision-making in healthcare settings. Role: Consortium PI |

**Current Funding**

| | |
|---|---|
| 2014-2021 | NIH/NIGMS U54 GM088558-10 NCE. MIDAS Center for Communicable Disease Dynamics. Role: PI |
| 2018-2022 | NIH/NIAID 5 R01 AI128344-01 (Hanage). Deep sequencing of pathogens to precisely define transmission networks using rare variants. Role: Co-PI |

2018-2021 National Institute for Health Research. PR-OD-1017-20006 (PI: Cooper / University of Oxford). Leveraging Pathogen Sequence Data and Adaptive Designs to Improve Vaccine Trials in Emerging Epidemics in LMICs. Role: Consortium PI

2018-2020 Pfizer Inc. A34479 (Lewnard). Changes in antimicrobial prescribing for otitis media in the era of pneumococcal conjugate vaccination. Role: Co-PI

2019-2024 CDC U01 IP001121-02 (PI: Rosenfeld / Carnegie Mellon University). Delphi Influenza Forecasting Center of Excellence. Role: Consortium PI

2020-2022 Wellcome Trust. 219759/Z/19/Z. Vaccine-avertable antimicrobial prescribing from influenza and RSV: a mixed-methods observational study. Role: PI

2020-2022 Wellcome Trust. 219812/Z/19/Z (Grad). Reducing antibiotic prescribing through a prioritized vaccination strategy. Role: Co-PI

2020-2023 Open Philanthropy Project / Silicon Valley Community Foundation. 2020-211809. Research and Policy Activities on Biosafety and Biosecurity. Role: PI

2020-2022 NIH/NCI U01 CA261277-01. Causal, Statistical and Mathematical Modeling with Serologic Data

2020-2025 CDC U01 CK000585-01 (Samore). Modeling and Simulation to support Epidemiological decision-making in Healthcare settings. Role: Consortium PI

2020-2022 Morris-Singer Foundation. Morris-Singer Fund for the Center for Communicable Disease Dynamics. Role: PI

## TEACHING EXPERIENCE:

### Full Courses

Biostatistics 516: Inferential Methods for Infectious Diseases. Co-developer and co-instructor of course.
*Taught 2011 (Spring 2)*

Epidemiology 260: Mathematical Models of Infectious Diseases: Developed course, sole instructor.
*Taught 2001, 2002, 2003, 2005, 2007, 2009, 2011, 2014, 2016, 2018, 2020 always d period (Spring 2).*

Interdepartmental 267-268: Seminar in Infectious Disease Epidemiology: Developed and taught course jointly with Dr. Megan Murray in 2000; sole instructor in 2001 and 2002.
*Taught 2000-2001 as full year; taught 2001 and 2002 as fall only (ID267ab).*

Interdepartmental 298: Inference in Infectious Disease Epidemiology. Developed course, sole instructor.
*Taught 2005, 2007 winter session.*

Epidemiology 502: Biology and Epidemiology of Antibiotic Resistance. Co-developed and co-taught course with Dr. Gili Regev-Yochay.
*Taught 2008, 2010, 2012, 2014, 2016, 2018, 2020 winter session.*

**Participation**

Epidemiology 201: Introduction to Epidemiology. One week each year (2 2-hr. lectures).
*Taught 2000-2007; coinstructor 2005-7.*

Epidemiology 200: Principles of Epidemiology. One lecture per year.
*Taught 2000-2005; coinstructor 2005-7.*

Epidemiology 289: two lectures on Infectious Disease Epidemiology, 2010

Interdepartmental 229: Epidemiology of Infectious Diseases of Importance in Developing Countries (and predecessors). One lecture per year.
*Taught 2000-2006.*

DBS205: Biological Sciences Seminars. One presentation of research per year.
*Taught 2002, 2005, 2015.*

RDS281 (now 285): Decision Analysis Methods in Public Health and Medicine. One lecture on infectious diseases and dynamic modeling.
*Taught 2002-2007, 2010.*

IMI225 Design and Development of a vaccine. One lecture per year.
*Taught 2007.*

IMI227 Genetics of Infectious Disease. One lecture per year.
*Taught 2007-8.*

Epidemiology 205: Practice of Epidemiology. Supervised one student.
*Participated 2000.*

Epidemiology 294: Screening. Two lectures on introductory Infectious Disease Epidemiology
*2011, (Spring 2)*

ID517 Public Health Response to Mass Emergencies. One lecture.
*Taught 2008.*

Life Sciences 120 (Harvard College): Global Health Threats.
*One to three lectures, 2011, 2012, 2016*

Probabilistic Risk Analysis (HSPH Continuing Education). One lecture per year.
*Taught 2002-2004.*

Health Science & Technology Microbiology (HMS). One lecture per year.
*Taught 2002, 2003, 2005, 2007, 2008, 2009.*

Modern Medical Microbe Hunters (HMS). One lecture per year.
*Taught 2000, 2001, 2002, 2004.*

Epidemiology 513: Issues in the Reporting of Clinical Trials. *Guest lecture 2011.*

Epidemiology 203. Four, 2-hour lectures per year on infectious disease epidemiology 2012, 2014, 2016, 2017, 2018,2019

ID250 Ethical Basis of Public Health Practice. One lecture per year
*Guest lecture 2015*

GHP539 Control of Infectious Diseases in Low/Mid Income Countries: Social, Political and Economic dimensions
*Guest lecture 2017*

MPH100
*Guest lecture 2019, 2020 (Spring and Fall)*

Harvard College Gen Ed 1098 Natural Disasters
*Guest lecture 2020*

**Short Courses Outside Harvard**

Harvard-Karolinska Summer School on Modern Methods in Biostatistics and Epidemiology, Treviso, Italy. Infectious Disease Epidemiology. Developed a 1-week intensive introductory course with exercises and was sole instructor. *Taught 2005.*

Hong Kong Centre for Health Protection Short Course in Mathematical Modelling of Infectious Diseases. Participated in course development and taught three lectures. *Taught 2006.*

Infection and Immunity in Children, Department of Paediatrics, Oxford University, UK. Delivered 1 lecture by videolink. *Taught June 2010.*

Winter Forum – Pandemic 2011. Duke Global Health Institute and Office for Undergraduate Education, Durham, NC. Delivered one lecture by videolink. *Taught January 2011.*

Practical Short Course in Infectious Disease Modeling. National Center for Immunization and Respiratory Diseases, US Centers for Disease Control & Prevention (CDC). Course director (collaboratively with Hong Kong University and Imperial College London) and instructor. *Taught June 2011.*

Erasmus Summer Program, Erasmus University, Rotterdam, Netherlands. Master Class taught by videolink. *Taught August 2011.*

Short Course in Infectious Disease Modeling: Hong Kong University and HSPH CCDD:
*Kuala Lumpur 2014, Bangkok 2012*

Course organizer and faculty: Short Course in Infectious Disease Modeling: HSPH CCDD, Imperial College London, Hong Kong University
*Centers for Disease Control and Prevention 2011, 2014*

Faculty Guest Lecturer: ICARe (International course on Antibiotic Resistance), Pasteur Institute, at Fondation Merieux, Les Pensieres, France.
*2018, 2019*

### Online Modules

Herd Immunity in: Vaccines 101, Harvard School of Public Health online course
*Recorded Summer 2014*

Heterogeneity in: Epidemics, University of Hong Kong HKUx EdX course
*Recorded Summer 2014*

### Guest Teaching Outside Harvard

Georgetown University Department of Microbiology and Immunology: guest lecture in Science Diplomacy and World Health, Tomoko Steen instructor (2014, 2016)

Princeton University Woodrow Wilson School: guest lecture in Topics in Development: Global Challenges of Infection, Burden and Control, Adel Mahmoud and Bryan Grenfell instructors (2016, 2018)

### Supervision

Research Scientist supervisor:

| | |
|---|---|
| 2005-2008 | Krzysztof Trzcinski, D.V.M., Ph.D., Research Scientist |
| 2008-2009 | Krzysztof Trzcinski, D.V.M., Ph.D., Senior Research Scientist (now Assistant Professor, University of Utrecht, Netherlands) |
| 2008-2010 | Edward Goldstein, Ph.D., Research Scientist |
| 2010-2018 | Edward Goldstein, Ph.D., Senior Research Scientist |
| 2019-present | Rene Niehus, Ph.D, Research Associate |

Postdoctoral supervisor:

| | |
|---|---|
| 2001-2005 | Krzysztof Trzcinski, D.V.M., Ph.D. Assistant Professor, University of Utrecht, Netherlands. |
| 2001-2002 | Noman Siddiqi, Ph.D. (Co-supervisor with Eric Rubin). Currently BL3 Manager, Harvard School of Public Health |
| 2001-2002 | Susan Huang, M.D., M.P.H. (Secondary advisor) (currently Professor of Infectious Disease, University of California, Irvine). |

| | |
|---|---|
| 2002-2003 | Ben Cooper, Ph.D. Professor, Nuffield Department of Medicine, Mahidol-Oxford Tropical Research Unit, Bangkok, Thailand |
| 2003-2005 | Michael Palmer, Ph.D. Currently working in the IT Industry |
| 2004-2008 | Gili Regev-Yochay, M.D. Currently Assistant Professor, Tel Aviv University and Head of Infectious Diseases Epidemiology Unit, Gertner Institute, Tel Aviv, Israel. |
| 2006-2008 | Debby Bogaert, M.D., Ph.D. Professor of Pediatric Infectious Diseases, University of Edinburgh |
| 2008 | Edward Goldstein, Ph.D. Senior Research Scientist, HSPH |
| 2010 | Daniel Weinberger, Ph.D. Assistant Professor, Yale School of Public Health |
| 2009-2011 | Joel Miller, Ph.D. Currently Senior Research Scientist, Institute for Disease Modeling, Seattle |
| 2010-2013 | Sarah Cobey, Ph.D. Associate Professor of Ecology and Evolution, University of Chicago |
| 2010-2014 | Yuan Li, Ph.D. Epidemiologist, CDC |
| 2010-2014 | Yonatan Grad, M.D., Ph.D. Assistant Professor, Harvard TH Chan School of Public Health |
| 2011-2013 | Nicholas Croucher, Ph.D. (co-advisor with W. Hanage). Senior Lecturer and Henry Dale Fellow, Imperial College |
| 2013-2016 | Colin Worby, Ph.D. (co-advisor with W. Hanage) Staff Scientist, Broad Institute. |
| 2013-2019 | Hsiao-Han Chang, Ph.D. (co-advisor with C. Buckee). Starting 2019: Assistant Professor, National Tsing Hua University, Taiwan |
| 2014-2016 | Nadia Abuelezam, Sc.D. (secondary advisor with George Seage). Currently Assistant Professor, Boston College School of Nursing. |
| 2014 | Ben Althouse, Ph.D. (external faculty advisor for his Santa Fe Institute Postdoc) |
| 2015-2017 | Kate Langwig, Ph.D. Assistant Professor of Ecology, Virginia Tech |
| 2015-2018 | Taj Azarian, Ph.D. Assistant Professor of Medicine, Burnett School of Biomedical Sciences, Department of Molecular Microbiology, University of Central Florida College of Medicine |
| 2015-2018 | Brian Arnold, Ph.D. Bioinformatics Scientist, Faculty of Arts and Sciences, Harvard University |
| 2015-2018 | Maria Georgieva, Ph.D. Postdoctoral Fellow, Department of Physiology, University of Lausanne |
| 2016-present | Samantha Palace, Ph.D. (co-supervisor with Y. Grad) |
| 2017-2018 | Lucy Li, Ph.D. Bioinformatics Scientist I, Chan Zuckerberg Biohub |
| 2017-2018 | Joseph Lewnard, Ph.D. Assistant Professor, Department of Epidemiology, UC Berkeley |
| 2017-2019 | Ayesha Mahmud, Ph.D. (Co-advisor with C. Buckee). Assistant Professor, Department of Demography, UC Berkeley |
| 2018-present | Pamela Martinez, Ph.D. (Co-advisor with C. Buckee) |
| 2019-present | Xueting Qiu, Ph.D. (Co-advisor with W. Hanage) |
| 2019-present | Lerato Magosi, D.Phil. |
| 2020 | Lee Kennedy-Shaffer, Ph.D., Assistant Professor, Vassar College |
| 2020-present | Rebecca Kahn, Ph.D. |

Doctoral student supervisor:

| | |
|---|---|
| 2000-2001 | Ivo Foppa (Epi). Currently Epidemiologist, Influenza Division, CDC |
| 2000-2005 | Hailay Teklehaimenot (Epi). Currently at Ministry of Health, Addis Ababa, Ethiopia |
| 2000-2001 | Robert Suruki (Epi): completed doctoral studies with another advisor; currently at GlaxoSmithKline. |
| 2001-2006 | Christina Mills (Epi). Currently Attending Physician, Boston Children's Hospital Boston |
| 2002-2005 | Alethea McCormick (Epi). Currently Research Associate, Harvard School of Public Health |
| 2002-2011 | Sibel Ascioglu (Epi). Currently at Glaxo SmithKline |
| 2003-2008 | Virginia Pitzer (Epi). Currently Assistant Professor, Yale School of Public Health |
| 2004-2012 | Jessica Hartman Jacobs (Epi) |
| 2006-2012 | Justin O'Hagan (Epi). Currently Head of Outcomes Research, Dengue, Merck. |
| 2006-2010 | Daniel Weinberger (BPH). Currently Assistant Professor, Yale School of Public Health |
| 2007-2008 | Chris Ford (BPH). Currently Postdoc, Broad Institute. |
| 2007-2008 | Karell Pelle (BPH) |
| 2014-2018 | Matthew Hitchings (Epi). Currently postdoctoral fellow, Emerging Pathogens Institute, University of Florida |
| 2016-present | Christine Tedijanto (Population Health Sciences/Epi) |
| 2016-present | Emma Accorsi (Population Health Sciences/Epi) |
| 2018-2020 | Rebecca Kahn (Population Health Sciences/Epi) |
| 2019-present | Keya Joshi (Population Health Sciences/Epi) |

Master's student supervisor:

| | |
|---|---|
| 2000-2002 | Alison Han (MPH) |
| 2000-2008 | Catherine Laine (Epi MSc). Currently Founder and Deputy Director, Appropriate Infrastructure Development Group. |
| 2001-2002 | Benjamin Ip, MD (MPH) |
| 2001-2002 | Rajneesh Hazarika, MD (MPH) |
| 2002-2004 | Hoa Nguyen, MD (MS) |
| 2003-2005 | Dereje Dengela (MS) |
| 2004-2005 | Heather Green (MS) |
| 2004-2005 | Wei-yen Lim, MD (MPH) |
| 2004-2005 | Phil James, MD (MPH) |
| 2005-2006 | Jeffrey Cloud, MD (MPH) |
| 2005-2006 | Yen-Tsung Huang, MD (MPH) |
| 2005-2006 | Minghua Chen, MD (MPH) |
| 2006-2007 | Chou-Cheng Lai, MD (MS) |
| 2006-2007 | Jennifer Shuford, MD (MPH) |
| 2006-2007 | Chih-Hao Chen, MD (MS) |
| 2006-2007 | Mark Brady (MPH) |
| 2007-2008 | Indrajit Hazarika, MD (MPH) |
| 2007-2008 | Hyun Joon Shin, MD (MPH) |
| 2007-2008 | Amit Vora (MPH) |
| 2005-2006 | Christie Jeon (MS) |

| | |
|---|---|
| 2004-2007 | Gili Regev-Yochay, MD (MS) |
| 2009-2011 | Weixiong Ke |
| 2010-2012 | Karen Aanensen |
| 2011-2013 | Talia Quandelacy |
| 2011-2013 | Patrick Mitchell |
| 2013-2014 | Fausto Bustos |
| 2016-2017 | Say Tat Ooi, MD (MPH) |
| 2016-2018 | Michael Martin (MS) |
| 2016-2018 | Inga Holmdahl (MS) |
| 2016-2018 | Rebecca Kahn (MS) |
| 2017-2019 | Sarah Lapidus (MS) |
| 2018-2020 | Nancy Li (MS) |
| 2019-2020 | Eva Rumpler (MS) |
| 2019-present | Rafia Bosan (MS) |

Undergraduate supervisor:

| | |
|---|---|
| Summer 2001 | Eneida Villanueva (Summer Minority Intern) |
| Fall 2001 | Jonathan Burton-MacLeod (Bio 91r supervised reading, FAS) |
| 2016-2018 | Alan Yang (Supervised research) |
| Summer 2018 | Tara E. Gallagher, Dartmouth College (Summer intern) |

Thesis committees:

| | |
|---|---|
| 2000-2001 | Megan Murray (Dr. P.H., completed 2000-1) |
| 2004-2007 | Eben Kenah (Epidemiology) |
| 2004-2005 | Y. Claire Wang (Health Policy and Management) |
| 2005 | Seema Thakore Meloni (Ph.D., Biological Sciences in Public Health) |
| 2005-2007 | Mary Farrow (Ph.D., Biological Sciences in Public Health) |
| 2007-2010 | Kevin Chan (Population & International Health) |
| 2008-2011 | Amy Bei (Ph.D., Biological Sciences in Public Health) |
| 2010-2013 | Chris Ford (Ph.D., Biological Sciences in Public Health) |
| 2010-2013 | Regina Joice (Ph.D., Biological Sciences in Public Health) |
| 2011 | Rachel Daniels (Ph.D., Biological Sciences in Public Health) |
| 2011-2017 | Freeman Suber MD (Ph.D., Biological Sciences in Public Health) |
| 2011-2012 | Tami Lieberman (Ph.D., Systems Biology) |
| 2011-2013 | Wei Wu (Epidemiology) |
| 2013 | Opponent, PhD of Rolf Ypma, University of Utrecht |
| 2014 | Clare Louise Kinnear, PhD, The University of Melbourne (external examiner) |
| 2015-2017 | Corey Peak (SD, Epidemiology) |
| 2015-2016 | Patrick Mitchell (SD, Epidemiology) |
| 2016 | Hattie Chung (PhD, Systems Biology, Harvard GSAS), examination committee |
| 2016 | Nicole Espy (PhD, BPH, defense committee) |
| 2015-2017 | Quizhi Chang (SD, Epidemiology) |
| 2017-2019 | Eric Mooring (SD, Epidemiology) |
| 2017-present | Rebecca Mandt (PhD, BPH) |

| | |
|---|---|
| 2017-2020 | Sarah McGough (PhD, Population Health Sciences) |
| 2018-2020 | Lee Kennedy-Shaffer (Biostatistics) |

Oral exam committees:

| | |
|---|---|
| 2001 | Yemane Yihdego (IID) |
| 2001 | Chris Mores (IID) |
| 2002 | Pride Chigwedere, MD (IID) |
| 2004 | Beth Ann Griffin (Biostatistics) |
| 2004 | Eben Kenah (Epidemiology) |
| 2004 | Laura Forsberg (Biostatistics) |
| 2007 | Kevin Chan (Population & International Health) |
| 2008 | Hsien-Ho Lin (Epidemiology) |
| 2009 | Regina Joice (BPH) |
| 2009 | Celene Chang (BPH) |
| 2009 | Kathleen Wirth (Epi) |
| 2011 | Freeman Suber (BPH) |
| 2011 | Wei Wu (Epi) |
| 2012 | Nicanor Rodriguez, DVM (IID) |
| 2016 | Corey Peak (Epi) |
| 2016 | Qiuzhi Chang (Epi) |

Laboratory rotations supervised:

| | |
|---|---|
| 2000 | Chun Chao (MS student, Immunology & Infectious Diseases) |
| 2004 | Adam MacNeil (PhD, Biological Sciences in Public Health) |
| 2006 | Daniel Weinberger (PhD, Biological Sciences in Public Health) |
| 2006 | Amy Bei (PhD, Biological Sciences in Public Health) |
| 2008 | Chris Ford (PhD, Biological Sciences in Public Health) |
| 2009 | Richa Gawande (PhD, Biological Sciences in Public Health) |
| 2010 | Sri Kalyanamaran (PhD, Biological Sciences in Public Health) |
| 2011 | Wen Xie (PhD, Biological Sciences in Public Health) |
| 2016 | Rebecca Mandt (PhD, Biological Sciences in Public Health) |

SCHOOL AND DEPARTMENTAL SERVICE

**Interdisciplinary Program in the Epidemiology of Infectious Disease**

- Steering committee, 2000-present
- Seminar Coordinator, 2000-present
- Associate Director, 2004-present

**Biological Sciences in Public Health Program**

- Admissions interviewer, 2001-present
- Curriculum Committee, 2006-2012

**Department of Epidemiology**

- Co-leader, department retreat, 2001

- Admissions committee, 2001-2014

**HSPH Epidemiology and Biostatistics Planning Committee**: member, 2003-2004

**HSPH Allston Planning Committee**: member, 2003-2004

**HSPH Information Technology Advisory Committee**: member, 2004-2005

**HSPH Committee on Educational Policy**: member, 2005-2008

**HSPH Standing Committee on Appointments, Reappointments, and Promotions**: member, 2008-present, vice-chair 2010-2012, chair 2012-2013

**University Pandemic Response Planning Committee:** member, 2005-present

**Bioinformatics Junior Faculty Search Committee**: member, 2007-2008

**Epidemiology Methods Junior Faculty Search Committee**: member, 2008

**Epidemiology Infectious Diseases Junior Faculty Search Committee**: chair, 2008

**HSPH Committee on the Concerns of Women Faculty**: member, 2010-2012

**HMS Subcommittee on Admissions for the MD/PhD:** member, 2010-2012, 2014-present

**Harvard University Office of Scholarly Communication Advisory Committee**, member, 2013-present

**Harvard T.H. Chan School of Public Health Dean Search Advisory Committee**, member, 2015

**Harvard T.H. Chan School of Public Health Faculty Judge, Postdoctoral Association Travel Awards**, member, 2016

**Epidemiology Junior Faculty Search Committee**, 2017-2018

BIBLIOGRAPHY

Peer-Reviewed Articles

1. Petrie M, Lipsitch M. Avian polygyny is most likely in populations with high variability in heritable male fitness. Proc R Soc Lond B. 1994 June 22;256(1347):275-80. doi: 10.1098/rspb.1994.0081.
2. Lipsitch M, Nowak MA. The evolution of virulence in sexually transmitted HIV/AIDS. J Theor Biol. 1995 Jun 21;174(4):427-40. doi: 10.1006/jtbi.1995.0109. PMID: 7666673.
3. Lipsitch M, Nowak MA, Ebert D, May RM. The population dynamics of vertically and horizontally transmitted parasites. Proc Biol Sci. 1995 Jun 22;260(1359):321-7. doi: 10.1098/rspb.1995.0099. PMID: 7630898.
4. Lipsitch M, Herre EA, Nowak MA. Host Population Structure and the Evolution of Virulence: A “Law Of Diminishing Returns”. Evolution. 1995 Aug;49(4):743-748. doi: 10.1111/j.1558-5646.1995.tb02310.x. PMID: 28565133.
5. Mangin KL, Lipsitch M, Ebert D. Virulence and transmission modes of two microsporidia in *Daphnia magna*. Parasitology. 1995;111(2):133-142. doi: 10.1017/S0031182000064878.
6. Lipsitch M, Siller S, Nowak MA. The Evolution of Virulence in Pathogens With Vertical and Horizontal Transmission. Evolution. 1996 Oct;50(5):1729-1741. doi: 10.1111/j.1558-5646.1996.tb03560.x. PMID: 28565576.
7. Lipsitch M, Moxon ER. Virulence and transmissibility of pathogens: what is the relationship? Trends Microbiol. 1997 Jan;5(1):31-7. doi: 10.1016/S0966-842X(97)81772-6. PMID: 9025233.
8. Antia R, Lipsitch M. Mathematical models of parasite responses to host immune defences. Parasitology. 1997;115 Suppl:S155-67. doi: 10.1017/s003118209700200x. PMID: 9571700.
9. Levin BR, Lipsitch M, Perrot V, Schrag S, Antia R, Simonsen L, Walker NM, Stewart FM. The population genetics of antibiotic resistance. Clin Infect Dis. 1997 Jan;24 Suppl 1:S9-16. doi: 10.1093/clinids/24.supplement_1.s9. PMID: 8994776.
10. Lipsitch M, Levin BR. The within-host population dynamics of antibacterial chemotherapy: conditions for the evolution of resistance. Ciba Found Symp. 1997;207:112-27; discussion 127-30. doi: 10.1002/9780470515358.ch8. PMID: 9189638.
11. Lipsitch M, Levin BR. The population dynamics of antimicrobial chemotherapy. Antimicrob Agents Chemother. 1997 Feb;41(2):363-73. doi: 10.1128/AAC.41.2.363. PMID: 9021193; PMCID: PMC163715.
12. Lipsitch M. Vaccination against colonizing bacteria with multiple serotypes. Proc Natl Acad Sci U S A. 1997 Jun 10;94(12):6571-6. doi: 10.1073/pnas.94.12.6571. PMID: 9177259; PMCID: PMC21091.
13. Lipsitch M. Evolution in health and disease. Trends Microbiol. 1997 Aug;5(8):303-5. doi: 10.1016/S0966-842X(97)01087-1. PMID: 9263405.
14. Datta A, Hendrix M, Lipsitch M, Jinks-Robertson S. Dual roles for DNA sequence identity and the mismatch repair system in the regulation of mitotic crossing-over in yeast. Proc Natl Acad Sci U S A. 1997 Sep 2;94(18):9757-62. doi: 10.1073/pnas.94.18.9757. PMID: 9275197; PMCID: PMC23263.
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